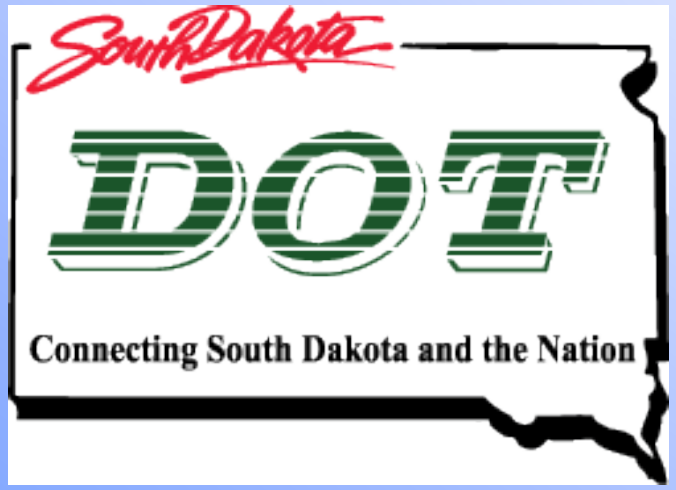
Hot Mix Testing Recertification

Quality Control / Quality Assurance



DOT Employee Timesheet Information

Charge to Office Overhead

AFE- 71B5

Function- 1174

IMPORTANT

Recertification is only for individuals currently certified and actively participating on Asphalt Concrete Projects (must attend certification class every 8 years)

PDH's available from SDDOT Certification Office

Call/e-mail:

Jerry Schaefer (605-773-5661)
Bryce Chambers (605-773-7042)
Nicki Miller (605-773-3403)

to request PDH's

Course Materials

- QC/QA Asphalt Concrete Training Manual
- Standard Specifications for Roads and Bridges (2015 Edition) - Sections 320 and 322
  - Supplemental Specifications
- South Dakota DOT Materials Manual - Minimum Sample and Test Requirements (MSTR)
- Example Problems Packet

Course Agenda

- Sampling Hot Mix & Liquid Asphalt
- Binder Content
- Hydrated Lime
- Moisture in the Mix
- RAP Content
- Asphalt Draindown
- Correlation Testing
- Core Dryback
- Recertification Exam

Asphalt Concrete Production Control

- Preconstruction meeting by Contractor
- Line of authority shown for both QC and QA personnel
- Certified testing personnel
- Calibrated test equipment
- Quality Control plan
- Test strip or procedure for establishing roller pattern

Certification Requirements

- Testers must be QC/QA certified in SD and have proof of certification
- Testing equipment calibration records shall be available on National Highway System Projects, Gyratory internal angle calibrated
- Requirements: Materials Testing & Inspection Certification Program Manual

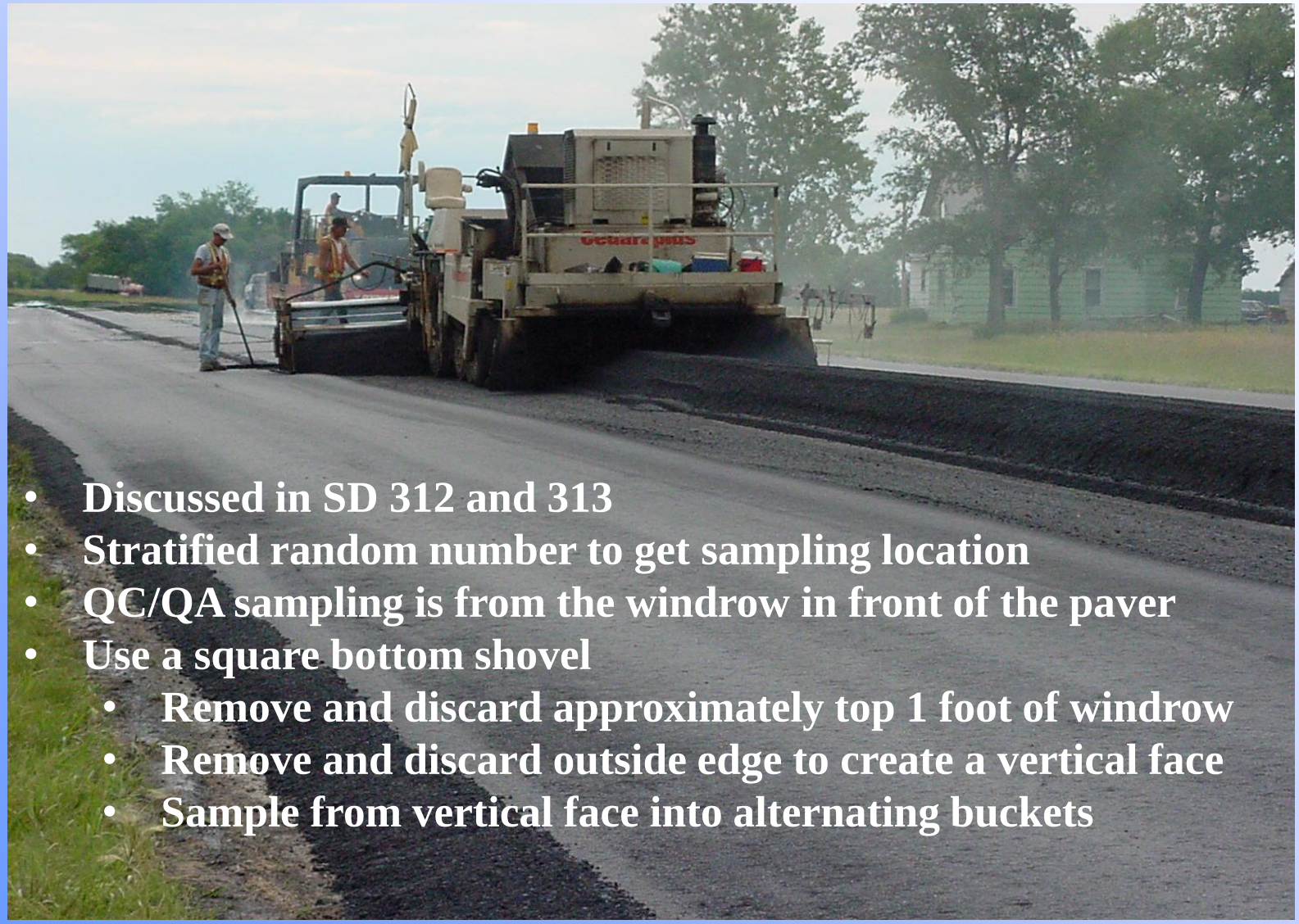
Certified Technicians

- The certified technicians must be present at the plant and roadway whenever the plant is supplying asphalt concrete to the roadway.

Mix Design Report

- Approved Mix Design Report
- Posted in both QC and QA lab
- Mix compaction temperatures
- Job Mix Formula
- Gyratory, Rice, & other Mix Design test results
- Manufactured Fines % or FAA
- Aggregate Composite % H_2O at SSD
- Aggregate composite Gsb and -#4 Gsb

Sampling Hot Mix



- Discussed in SD 312 and 313
- Stratified random number to get sampling location
- QC/QA sampling is from the windrow in front of the paver
- Use a square bottom shovel
  - Remove and discard approximately top 1 foot of windrow
  - Remove and discard outside edge to create a vertical face
  - Sample from vertical face into alternating buckets

Liquid Asphalt Samples

- PG Grades, sampled by contractor, witnessed by DOT, inline between storage tank and dryer drum, Frequency once per 200 ton, Daily oil cutoff from tank stick, (SD 314), Spot check on asphalt binder during the day, Maintain quantities of PG asphalt used
- Asphalt Emulsions and Cutbacks, sampled once per 100 ton, DOT, shot records and quantities used
- Materials Manual MSTR and Section 2 Training Manual

Binder Content

- Asphalt binder sample
  - In-line between storage tank and mix plant
  - One sample per 200 ton
- Asphalt binder content
- Daily cutoff (SD 314)
  - Tank stick
  - Form DOT-89
  - Problem

Problem #1

Asphalt Binder Content (SD 314)

Complete the DOT-89 form below. What is the Job Mix Formula Tolerance? _____

TANK METHOD

A. Beginning Specific Gravity of Bitumen @ 60°F	1.035
B. Beginning Weight Per Gallon @ 60°F	8.630
C. Temperature of Bitumen in Tank When Check Starts	295*
D. Weight Per Gallon of Bitumen at Temperature	
E. Gallons in Tank When Check Starts (calibrated stick)	29272
Gallons at Start (at start of tank use)	☐
f. Weight of Bitumen in Tank (start check) (D x E / 2000)	
G. Weight of Bitumen Added to Tank(s)	
H. Temperature of Bitumen in Tank When Check Ends	295*
I. Gallons in Tank When Check Ends (calibrated stick)	29094
J. Ending Specific Gravity of Bitumen @ 60°F	1.035
K. Ending Weight Per Gallon @ 60°F	8.630
L. Weight Per Gallon at Temperature	
M. Weight of Bitumen in Tank (end check) (I x L / 2000)	
Left in Storage (at end of tank use)	☐
N. Weight of Bitumen Used (F + G - M)	
O. Weight of Mix Produced (Tons)	
P. Percent Bitumen in Mix (N / O x 100)	

*Temp. Correction Factor Chart in SD 314

G. Load #	Invoice #	Tons
1	10007	26.80
2	10009	26.47
3	10012	33.79
4	10017	40.64
5	10019	25.65

Summary of Mix Produced

To Road	3707.24	Tons
Plant Waste	0.0	Tons
Road Waste	0.0	Tons
To Others	0.0	Tons
Produced	3707.24	Tons

Problem #1 - Answer

Asphalt Binder Content (SD314)

- D. Weight Per Gallon of Bitumen at Temperature

$$= 8.630 \times 0.9204 \text{ (Temp. Correction Factor)} = \mathbf{7.943}$$

- f. Weight of Bitumen in Tank (start check)

$$= D \times \frac{E}{2000} = 7.943 \times \left(\frac{29272}{2000}\right) = \mathbf{116.25}$$

- G. Weight of Bitumen Added to Tank(s)

$$\text{Add Loads together} \rightarrow 26.80 + 26.47 + 33.79 + 40.64 + 25.65 = \mathbf{153.35}$$

- L. Weight Per Gallon at Temperature

$$= 8.630 \times 0.9204 \text{ (Temp. Correction Factor)} = \mathbf{7.943}$$

Problem #1 - Answer

Asphalt Binder Content (SD314)

- M. Weight of Bitumen in Tank (end check)

$$= \quad L \times \frac{I}{2000} \quad = \quad 7.943 \times \left(\frac{29094}{2000}\right) \quad = \quad \mathbf{115.55}$$

- N. Weight of Bitumen Used

$$= \quad f + G - M \quad = \quad 116.25 + 153.35 - 115.55 \quad = \quad \mathbf{154.05}$$

- O. Weight of Mix Produced (Tons)
  - From Summary of Mix Produced = **3707.24 Tons**
- P. Percent Bitumen in Mix

$$= \quad \left(\frac{N}{O}\right) \times 100 = \quad \left(\frac{154.05}{3707.24}\right) \times 100 \quad = \quad \mathbf{4.16 \ \%}$$

- Percent used by Test: **4.2 %**

Problem #1 - Answer

Asphalt Binder Content (SD 314)

Complete the DOT-89 form below. What is the Job Mix Formula Tolerance? ± 0.3

TANK METHOD

A. Beginning Specific Gravity of Bitumen @ 60°F	1.035
B. Beginning Weight Per Gallon @ 60°F	8.630
C. Temperature of Bitumen in Tank When Check Starts	295*
D. Weight Per Gallon of Bitumen at Temperature	7.943
E. Gallons in Tank When Check Starts (calibrated stick)	29272
Gallons at Start (at start of tank use)	☐
f. Weight of Bitumen in Tank (start check) (D x E / 2000)	116.25
G. Weight of Bitumen Added to Tank(s)	153.35
H. Temperature of Bitumen in Tank When Check Ends	295*
I. Gallons in Tank When Check Ends (calibrated stick)	29094
J. Ending Specific Gravity of Bitumen @ 60°F	1.035
K. Ending Weight Per Gallon @ 60°F	8.630
L. Weight Per Gallon at Temperature	7.943
M. Weight of Bitumen in Tank (end check) (I x L / 2000)	115.55
Left in Storage (at end of tank use)	☐
N. Weight of Bitumen Used (F + G - M)	154.05
O. Weight of Mix Produced (Tons)	3707.24
P. Percent Bitumen in Mix (N / O x 100)	4.16

*Temp. Correction Factor Chart in SD 314

G. Load #	Invoice #	Tons
1	10007	26.80
2	10009	26.47
3	10012	33.79
4	10017	40.64
5	10019	25.65

Summary of Mix Produced

To Road	3707.24	Tons
Plant Waste	0.0	Tons
Road Waste	0.0	Tons
To Others	0.0	Tons
Produced	3707.24	Tons

Hydrated Lime

- One sample per 750 tons, DOT
- Covered by certified lime plant if furnished by Pete Lien and Sons RC, sampled by DOT Central Lab on random basis
- Lime cutoff form DOT-33Q
- Specification allows Contractor to add 1.00% hydrated lime to mix and not have to verify the Tensile Strength Ratio (TSR), min. 80 required, for all levels.


Enclosed Pug Mill


Enclosed Pug Mill
PUGMILL
SYSTEMS

Load Cells for Weighing Lime


Issues
Releasing lime into the air

Hydrated Lime

- Specification requires Contractor to add hydrated lime to aggregate containing a minimum moisture content of 1.0% above the saturated surface dry (SSD) condition of the aggregate as noted on the approved job mix formula.
- Problem

Problem #2

Hydrated Lime

Complete the DOT-33Q form below. What is the Job Mix Formula Tolerance? _____

TANK METHOD

A. Weight of Lime in Tank at Start (Tons)	41.23
☐ Tons at Start (at start of project only)	
B. Weight of Lime Added to Tank (Tons)	
C. Weight of Lime in Tank at End (Tons)	39.37
☐ Left in Storage (at end of project only)	
D. Weight of Lime Used (A + B - C) (Tons)	
E. Weight of Mix Produced (Tons)	
F. Percent of Lime in Mix (D / E x 100)	

B.

Load #	Invoice #	Tons
2	5552	34.90

Summary of Mix Produced

To Road	3707.24
Plant Waste	0.0
Road Waste	0.0
To Others	0.0
Produced	3707.24

Problem #2 - Answer

Hydrated Lime

Complete the DOT-33Q form below. What is the Job Mix Formula Tolerance? ± 0.10

TANK METHOD

A. Weight of Lime in Tank at Start (Tons)	41.23
☐ Tons at Start (at start of project only)	
B. Weight of Lime Added to Tank (Tons)	34.90
C. Weight of Lime in Tank at End (Tons)	39.37
☐ Left in Storage (at end of project only)	
D. Weight of Lime Used (A + B - C) (Tons)	36.76
E. Weight of Mix Produced (Tons)	3707.24
F. Percent of Lime in Mix (D / E x 100)	0.99

B.

Load #	Invoice #	Tons
2	5552	34.90

Summary of Mix Produced

To Road	3707.24
Plant Waste	0.0
Road Waste	0.0
To Others	0.0
Produced	3707.24

Moisture in the Mix

SD 305

- One sample per 10,000 tons of hot mix, DOT sampled from paver area
- 1,500 to 3,000 gram sample
- (SD 305)
- Problem

Problem #3

Moisture in the Mix

Complete the calculations below. What is the max % moisture allowed? _____

A.	Container Number:	1
B.	Weight of container and cover (g):	222.3
C.	Weight of container, cover and sample (g):	1723.7
D.	Apparent dry weight (g): (C – B)	
E.	Actual dry weight (g): (J – B)	
F.	Moisture in material (g): (D – E)	
G.	% Moisture in the Mix: (F / E) * 100	

DRYING WEIGH BACK AREA (H)

	Time	Weight (g)
	12:00 PM	1722.1
	2:00 PM	1721.9
	3:00 PM	1721.8
J.	**Weight of material and pan:**	**1721.8**

Percent Moisture in the Mix: ☐

Spec: ☐

Problem #3 - Answer

Moisture in the Mix

A.	Container Number:	1
B.	Weight of container and cover (g):	222.3
C.	Weight of container, cover and sample (g):	1723.7
D.	Apparent dry weight (g): (C – B)	**1501.4**
E.	Actual dry weight (g): (J – B)	**1499.5**
F.	Moisture in material (g): (D – E)	**1.9**
G.	% Moisture in the Mix: (F / E) * 100	**0.13**

D = 1723.7 – 222.3 = 1501.4

E = 1721.8 – 222.3 = 1499.5

F = 1501.4 – 1499.5 = 1.9

$$\mathbf{G} = \left(\frac{1.9}{1499.5}\right) \times 100 = 0.13$$

DRYING WEIGH BACK AREA (H)

	Time	Weight (g)
	12:00 PM	1722.1
	2:00 PM	1721.9
	3:00 PM	1721.8
J.	**Weight of material and pan:**	**1721.8**

Percent Moisture in the Mix: **0.1 %**

Spec: **0.3% max**

Impermeable Mix + Heat + Moisture

Warm Mix – Foaming Device

RAP Content

Q_R or HR mixes

- RAP percentage
  - Daily cutoff
  - Requirements for scales?
    - 0.5% accuracy based on the net weight
  - Belt scales and moisture contents
  - Form DOT-93
  - Problem

Problem #4

RAP Content

Complete the DOT-93 form below. Use the RAP equation sheet found in the Problems Packet. What is the Job Mix Formula Tolerance? _____

WEIGH TICKET ENTRIES

A.	Total of hot mix produced by tickets (tons)	3707.24
B.	Moisture in the mix percentage (most recent one tested)	0.13
C.	Moisture in the mix (tons)	
D.	Total dry amount of hot mix produce for the day (tons)	
E.	Added binder percentage by cutoff (DOT-89)	4.20
F	Total amount of added binder (tons)	
G.	Added lime percentage by cutoff (DOT-33Q)	0.99
H.	Total amount of added lime (tons)	
I.	Total dry Virgin MA and RAP from tickets & cutoffs (tons)	

WEIGH BRIDGE ENTRIES

J.	Weight of Virgin MA from weight bridge totalizer (tons)	2761.1
K.	Percentage moisture in Virgin MA	3.9
L.	Weight of water in in Virgin MA (tons)	
M.	Weight of dry Virgin MA (tons)	
N.	Weight of RAP from weigh bridge totalizer (tons)	830.2
O.	Percent moisture in RAP	0.2
P.	Weight of water in the RAP mixture (tons)	
Q.	Weight of dry RAP from weigh bridge totalizer (tons)	
R.	Total dry Virgin MA and RAP from weigh bridges (tons)	

RAP PERCENTAGES

S.	Percentage of RAP based on weigh bridges	
T.	Percentage of RAP based on weigh tickets	
U.	% difference between scale tickets and weigh bridges	

Problem #4 - Answer

RAP Content

WEIGH TICKET ENTRIES

C. Moisture in the mix (tons):

$$\frac{A \times \left(\frac{B}{100}\right)}{\left[1 + \left(\frac{B}{100}\right)\right]} = \frac{3707.24 \times \left(\frac{0.13}{100}\right)}{\left[1 + \left(\frac{0.13}{100}\right)\right]} = \mathbf{4.81}$$

D. Total dry amount of hot mix produced for the day (tons):

$$D = A - C = 3707.24 - 4.81 = \mathbf{3702.43}$$

F. Total amount of added binder (tons):

$$F = A \times \left(\frac{E}{100}\right) = 3707.24 \times \left(\frac{4.20}{100}\right) = \mathbf{155.70}$$

H. Total amount of added lime (tons):

$$H = A \times \left(\frac{G}{100}\right) = 3707.24 \times \left(\frac{0.99}{100}\right) = \mathbf{36.70}$$

I. Total dry Virgin MA and RAP from tickets & cutoffs (tons):

$$I = D - (F + H) = 3702.43 - (155.70 + 36.70) = \mathbf{3510.03}$$

Problem #4 - Answer

RAP Content

WEIGH BRIDGE ENTRIES

L. Weight of water in Virgin MA (tons): $\dfrac{J \times \left(\frac{K}{100}\right)}{\left[1 + \left(\frac{K}{100}\right)\right]} = \dfrac{2761.1 \times \left(\frac{3.9}{100}\right)}{\left[1 + \left(\frac{3.9}{100}\right)\right]} = \mathbf{103.64}$

M. Weight of dry Virgin MA (tons):

$$M = J - L = 2761.1 - 103.64 = \mathbf{2657.46}$$

P. Weight of water in the RAP mix (tons):): $\dfrac{N \times \left(\frac{O}{100}\right)}{\left[1 + \left(\frac{O}{100}\right)\right]} = \dfrac{830.2 \times \left(\frac{0.2}{100}\right)}{\left[1 + \left(\frac{0.2}{100}\right)\right]} = \mathbf{1.66}$

Q. Weight of dry RAP from weight bridge totalizer (tons):

$$Q = N - P = 830.2 - 1.66 = \mathbf{828.54}$$

R. Total dry Virgin MA and RAP from weigh bridges (tons):

$$R = M + Q = 2657.46 + 828.54 = \mathbf{3486.0}$$

Problem #4 - Answer

RAP Content

RAP PERCENTAGES

S. Percentage of RAP based on weigh bridges:

$$S = \left(\frac{Q}{R}\right) \times 100 = \left(\frac{828.54}{3486.0}\right) \times 100 = \mathbf{23.8\,\%}$$

T. Percentage of RAP based on weigh tickets:

$$T = \left(\frac{Q}{I}\right) \times 100 = \left(\frac{828.54}{3510.03}\right) \times 100 = \mathbf{23.6\,\%}$$

U. % difference between scale tickets and weigh bridges:

$$U = \left(\frac{I - R}{I}\right) \times 100 = \left(\frac{3510.03 - 3486.0}{3510.03}\right) \times 100 = \mathbf{0.68\,\%}$$

Percent RAP by Test (weigh bridges) = 24 %

JMF tolerance = ± 5

Problem #4 - Answer

RAP Content

WEIGH TICKET ENTRIES

A.	Total of hot mix produced by tickets (tons)	3707.24
B.	Moisture in the mix percentage (most recent one tested)	0.13
C.	Moisture in the mix (tons)	**4.81**
D.	Total dry amount of hot mix produce for the day (tons)	**3702.43**
E.	Added binder percentage by cutoff (DOT-89)	4.20
F	Total amount of added binder (tons)	**155.7**
G.	Added lime percentage by cutoff (DOT-33Q)	0.99
H.	Total amount of added lime (tons)	**36.7**
I.	Total dry Virgin MA and RAP from tickets & cutoffs (tons)	**3510.03**

WEIGH BRIDGE ENTRIES

J.	Weight of Virgin MA from weight bridge totalizer (tons)	2761.1
K.	Percentage moisture in Virgin MA	3.9
L.	Weight of water in in Virgin MA (tons)	**103.64**
M.	Weight of dry Virgin MA (tons)	**2657.46**
N.	Weight of RAP from weigh bridge totalizer (tons)	830.2
O.	Percent moisture in RAP	0.2
P.	Weight of water in the RAP mixture (tons)	**1.66**
Q.	Weight of dry RAP from weigh bridge totalizer (tons)	**828.54**
R.	Total dry Virgin MA and RAP from weigh bridges (tons)	**3486.0**

RAP PERCENTAGES

S.	Percentage of RAP based on weigh bridges	**23.8** → **24 %**
T.	Percentage of RAP based on weigh tickets	**23.6**
U.	% difference between scale tickets and weigh bridges	**0.68**

What is the Job Mix Formula Tolerance? **± 5 %**

Asphalt Draindown Procedure

SD 306

- Used on Class S or SMA
- Determines the amount of draindown material in an uncompacted bituminous paving mixture
- Problem

Problem #5

Draindown

Calculate the draindown percentage on the DOT-91 form below.

Sample ID
File No.

Asphalt Draindown Worksheet

DOT - 91
9-15

PROJECT _____ COUNTY _____ PCN _____

Field # _____ Date Sampled _____ Date Tested _____

Sampled By _____ Tested By _____ Checked By _____

MixType Class S Asphalt Cement _____ Cellulose Fibers _____

			Weight of test sample	1327.4	grams
Weight of container empty	52.3	grams	Weight of container after test	53.1	grams
Draindown		≤ 0.3%	Temperature of test sample	300	°F

Problem #5 - Answer

Sample ID
File No.

Asphalt Draindown Worksheet

DOT - 91
9-15

PROJECT _____ COUNTY _____ PCN _____

Field # _____ Date Sampled _____ Date Tested _____

Sampled By _____ Tested By _____ Checked By _____

MixType Class S Asphalt Cement _____ Cellulose Fibers _____

			Weight of test sample	1327.4	grams
Weight of container empty	52.3	grams	Weight of container after test	53.1	grams
Draindown	0.1 %	≤ 0.3%	Temperature of test sample	300	°F

$$\left(\frac{(53.1 - 52.3)}{1327.4}\right) \times 100 = 0.06 = 0.1\%$$

Hot Mix Correlation Testing

- Sample supplied by contractor, may be plant produced if spot leveling, Specifications
- Gyratory (SD 318)
- Theoretical Max Sp. Gr., Rice (SD 312)
- Air Void calculation on form DOT-69

Bulk Specific Gravity Reheat Correlation

- 1st sublot of material
- Cool to room temperature, reheat to compaction temperature
- Used for IA tolerances and if QC vs. QA correlation problems occur
- Shows aggregate and asphalt mixture absorption rates

Approximate Test Size and Tests Needed

- Bulk Specific Gravity of Compacted mix, Gyratory specimens (SD 318), 2 made @ N_{des} at 115 ± 5 mm , approximately 4500 to 4800 grams
- If gyratory specimen doesn't compact to 115 ± 5 mm, use the following equation:

$$\frac{115 \times [\text{Actual wt. of specimen (g)}]}{(\text{Actual height of specimen})} = \text{amount needed for correct height}$$

(115 x 4505.6) / 110.5 = 4689.1 grams

- Theoretical maximum specific gravity of uncompacted mix, Rice, (SD 312)
  - ¾" nominal mix → 2,000 grams min.
  - ½" nominal mix → 1,500 grams min.

Problem #6

DOT-86
Gyratory Worksheet

Complete the DOT-86 for a Q2R Mix.

Use the equation sheet in the Problems Packet.

Mix Temp	275

% binder Pb	5.4	**N initial**		**Gse**	
Gsb	2.609	**N design**		**Pba**	
binder Gb	1.035	**N max**		**Pbe**	
dust (- #200)	3.70				
lime	0.99				

No. of gyrations

		Spec. A (Ndes)		Spec. B (Ndes)	
dust(-#200) + lime		@ N ini	@ N des	@ N ini	@ N des
a) Height, mm		124.2	115.7	124.6	115.9
b) Weight in air			4738.1		4746.5
c) Weight in water			2724.9		2729.9
d) SSD Weight			4741.8		4749.6
e) Gmb (measured)	b / (d - c)				
f) Gmb (calculated)					

	Gmm #1	Gmm #2
Weight of sample in air	1505.3	1523.9
Weight of canister + H_2O	1275.3	1275.3
Weight of canister + H_2O + sample	2166.6	2177.5
Temperature of water	24.4	24.4
H_2O correction factor	1.0001	1.0001
Rice SpGr (Gmm)		

Average Max SpGr (Gmm)

	N initial	N design
Average Gmb		
% of Rice SpGr (Gmm)		

% Air Voids (Va)		**% VMA**		**% VFA**		**Dust to Binder Ratio**	
Specs:							

Problem #6

DOT-86
Gyratory Worksheet

$$\textbf{dust}\ (-\#200)\ +\ \textbf{lime}\ =\ 3.7\ +\ 0.99\ =\ \mathbf{4.7}$$

$$\textbf{\textit{Spec. A}:}\ \textbf{Gmb measured}\ =\ \frac{\text{b}}{(\text{d}-\text{c})}\ =\ \frac{4738.1}{(4741.8\ -\ 2724.9)}\ =\ \mathbf{2.349}$$

$$\textbf{\textit{Spec. B}:}\ \textbf{Gmb measured}\ =\ \frac{\text{b}}{(\text{d}-\text{c})}\ =\ \frac{4746.5}{(4749.6\ -\ 2729.9)}\ =\ \mathbf{2.350}$$

$$\textbf{\textit{Spec. A}:}\ \textbf{Gmb calculated}\ =\ \frac{(\text{Gmbmeas}\ \times\ \text{height @ Ndes})}{(\ \text{height @ Nini}\ )}\ =\ \frac{(2.349\ \times\ 115.7)}{124.2}$$

$$=\ \mathbf{2.188}$$

$$\textbf{\textit{Spec. B}:}\ \textbf{Gmb calculated}\ =\ \frac{(\text{Gmbmeas}\ \times\ \text{height @ Ndes})}{(\ \text{height @ Nini}\ )}\ =\ \frac{(2.350\ \times\ 115.9)}{124.6}\ =\ \mathbf{2.186}$$

$$\text{Average Gmb @ Ninitial}\ =\ \frac{(\ 2.188\ +\ 2.186\ )}{2}\ =\ 2.187$$

$$\text{Average Gmb @ Ndesign}\ =\ \frac{(\ 2.349\ +\ 2.350\ )}{2}\ =\ 2.350$$

No. of gyrations

- Spec. Book Sect. 322 (Q2R – Table G)
  - $N_{initial}\ =\ 6$
  - $N_{design}\ =\ 50$
  - $N_{max}\ =\ 75$

Problem #6

DOT-86
Gyratory Worksheet

$$\textbf{Rice SpGr} = \left[\frac{\text{wt.of sample in air}}{(\text{wt.of sample in air}) + (\text{wt.of canister+ } H_2O) - (\text{wt.of canister+}H_2O\text{+sample})}\right] \times \text{Corr. Factor}$$

$$\text{Gmm \#1} = \left[\frac{1505.3}{(1505.3 + 1275.3 - 2166.6)}\right] \times 1.0001 = \mathbf{2.452}$$

$$\text{Gmm \#2} = \left[\frac{1523.9}{(1523.9 + 1275.3 - 2177.5)}\right] \times 1.0001 = \mathbf{2.451}$$

$$\text{Average Max SpGr (Gmm)} = \frac{(2.452 + 2.451)}{2} = \mathbf{2.452}$$

$$\text{\% of Rice SpGr (Gmm) @ Ninitial} = \frac{\text{Avg. Gmb}}{\text{Avg. Max SpGr}} \times 100 = \frac{2.187}{2.452} \times 100 = \mathbf{89.2\ \%}$$

$$\text{\% of Rice SpGr (Gmm) @ Ndesign} = \frac{\text{Avg. Gmb}}{\text{Avg. Max SpGr}} \times 100 = \frac{2.350}{2.452} \times 100 = \mathbf{95.8\ \%}$$

Problem #6

DOT-86
Gyratory Worksheet

$$\%\ \textbf{Air Voids (Va)} = \left(\frac{\text{Gmm} - \text{Gmb}}{\text{Gmm}}\right) \times 100 = \left(\frac{2.452 - 2.350}{2.452}\right) \times 100 = \mathbf{4.2\%}$$

$$\textbf{Ps} = 100 - \text{Pb} = 100 - 5.4 = \mathbf{94.6\ \%}$$

$$\%\ \textbf{VMA} = 100 - \left(\frac{\text{Gmb} \times \text{Ps}}{\text{Gsb}}\right) = 100 - \left(\frac{2.350 \times 94.6}{2.609}\right) = \mathbf{14.8\ \%}$$

$$\%\ \textbf{VFA} = \left(\frac{\text{VMA} - \text{Va}}{\text{VMA}}\right) \times 100 = \left(\frac{14.8 - 4.2}{14.8}\right) \times 100 = \mathbf{72\ \%\ (whole\ percent)}$$

$$\textbf{Gse} = \frac{100 - \text{Pb}}{\left(\frac{100}{\text{Gmm}}\right) - \left(\frac{\text{Pb}}{\text{Gb}}\right)} = \frac{100 - 5.4}{\left(\frac{100}{2.452}\right) - \left(\frac{5.4}{1.035}\right)} = \mathbf{2.660}$$

Problem #6

DOT-86
Gyratory Worksheet

$$\textbf{Pba} = 100 \times \left(\frac{\text{Gse} - \text{Gsb}}{\text{Gse} \times \text{Gsb}}\right) \times \text{Gb} = 100 \times \left(\frac{2.660 - 2.609}{2.660 \times 2.609}\right) \times 1.035 = \mathbf{0.76\ \%}$$

$$\textbf{Pbe} = \text{Pb} - \left(\frac{\text{Pba} \times \text{Ps}}{100}\right) = 5.4 - \left(\frac{0.76 \times 94.6}{100}\right) = \mathbf{4.7\ \%}$$

$$\textbf{Dust to Binder Ratio} = \left(\frac{\text{dust} - \#200 + \text{lime}}{\text{Pbe}}\right) = \left(\frac{4.7}{4.7}\right) = \mathbf{1.0}$$

Specs: **Spec Book - Sect. 322 (Q2R mix)**

- TABLE L (% Air Voids) → **4.0% ± 1.0%**
- TABLE I (% VMA) → ***minimum 13.5% during production**
- TABLE J (% VFA) → ***evaluated @ mix design only**
- Dust to Binder Ratio → **0.6 to 1.4 -or- 0.8 to 1.6 (depends on gradation @ mix design)**

Problem #6

Answer
Q2R Mix

Mix Temp	275

		No. of gyrations			
% binder Pb	5.4	**N initial**	6	**Gse**	2.660
Gsb	2.609	**N design**	50	**Pba**	0.76
binder Gb	1.035	**N max**	75	**Pbe**	4.7
dust (- #200)	3.70				
lime	0.99				
dust(-#200) + lime	4.7				

	Spec. A (Ndes)		Spec. B (Ndes)	
	@ N ini	@ N des	@ N ini	@ N des
a) Height, mm	124.2	115.7	124.6	115.9
b) Weight in air		4738.1		4746.5
c) Weight in water		2724.9		2729.9
d) SSD Weight		4741.8		4749.6
e) Gmb (measured) b / (d - c)		2.349		2.350
f) Gmb (calculated)	2.188		2.186	

	Gmm #1	Gmm #2
Weight of sample in air	1505.3	1523.9
Weight of canister + H_2O	1275.3	1275.3
Weight of canister + H_2O + sample	2166.6	2177.5
Temperature of water	24.4	24.4
H_2O correction factor	1.0001	1.0001
Rice SpGr (Gmm)	2.452	2.451

Average Max SpGr (Gmm)	2.452

	N initial	N design
Average Gmb	2.187	2.350
% of Rice SpGr (Gmm)	89.2	95.8

% Air Voids (Va)	4.2	**% VMA**	14.8	**% VFA**	72	**Dust to Binder Ratio**	1.0
Specs:	4.0 ± 1.0		*13.5 min		*mix design only		0.6 – 1.4 -or- 0.8 – 1.6

QC/QA In Place Pavement Density

- 2 samples per 1000 tons, random location determined by DOT, (SD 315)
- No buffer zone
- Cores taken by contractor and sawed
- Inspected for damage to cores
- Tested by DOT, evaluated statistically for specification

Core Dryback Procedure

- Test procedure (SD 315)
- Get added moisture from coring process out of cores
- Form DOT-42Q
- **PROBLEM**

Problem #7

Core Dryback

Complete the DOT-42Q form below.

Theoretical Maximum Specific Gravity

Sublot No.	1	2	3	4	5				
Max. Sp. Gr.	2.447	2.452	2.452	2.450	2.441				

Lot Average Maximum Specific Gravity (Standard) _____

In-Place Density Measurement

Percent of Standard = [(Core Bulk Specific Gravity / Lot Average Maximum Specific Gravity)] x 100

Core Sublot No.	Height	Rand Nbr.	Cumulative Tonnage	Station for Core	Rand Nbr	Paving Width	Distance from C/L		Actual Dry Weight	Weight in Water	SSD Weight	Reheat Correction Factor	Core Bulk Specific Gravity	Percent of Standard	Average Percent Standard
1 A	2.00	.61	305	165+52	.28	11	3.1	LT	1340.3	757.7	1351.7		2.256		
1 B	2.25	.99	995	123+71	.65	11	7.2	LT	1430.2	808.0	1440.2		2.262		
2 A	2.13	.06	1,030	121+59	.17	11	1.9	LT	1308.2	739.8	1314.7		2.276		
2 B	2.50	.65	1,825	73+42	.18	11	2.0	LT	1530.2	860.2	1541.3		2.247		
3 A	2.13	.01	2,005	62+51	.82	11	9.0	LT	1312.5	739.0	1321.8		2.252		
3 B	2.25	.32	2,660	22+82	.69	11	7.6	LT	1386.8	780.6	1397.0		2.250		
4 A	2.38	.00	3,000	2+22	.26	11	2.9	LT	1504.5	851.9	1510.3		2.285		
4 B	1.75	.84	3,920	143+72	.90	11	9.9	RT	1197.8	679.8	1202.2		2.293		
5 A	2.38	.36	4,180	127+23	.10	11	1.1	RT	1441.7	802.7	1449.0		2.231		
5 B	2.25	.07	4,535	104+71	.59	11	6.5	RT	1463.7	832.4	1467.9		2.303		

Percent Density: _____

Problem #7 - Answer

Core Dryback

$$\textbf{Lot Avg. Max SpGr (Standard)} = \frac{(2.447 + 2.452 + 2.452 + 2.450 + 2.441)}{5} = \mathbf{2.448}$$

$$\textbf{Percent of Standard} = \left(\frac{\text{Core Bulk Specific Gravity}}{\text{Lot Avg.Max SpGr}}\right) \times 100$$

(round to the hundredth)

$$\textbf{Average Percent Standard} = \frac{(\%\text{ of Standard A} + \%\text{ of Standard B})}{2}$$

(round to the tenth)

Problem #7 - Answer

Core Dryback

Complete the DOT-42-Q form below.

Theoretical Maximum Specific Gravity

Sublot No.	1	2	3	4	5				
Max. Sp. Gr.	2.447	2.452	2.452	2.450	2.441				

Lot Average Maximum Specific Gravity (Standard) **2.448**

In-Place Density Measurement

Percent of Standard = [(Core Bulk Specific Gravity / Lot Average Maximum Specific Gravity)] x 100

Core Sublot No.	Height	Rand Nbr.	Cumulative Tonnage	Station for Core	Rand Nbr	Paving Width	Distance from C/L		Actual Dry Weight	Weight in Water	SSD Weight	Reheat Correction Factor	Core Bulk Specific Gravity	Percent of Standard	Average Percent Standard
1 A	2.00	.61	305	165+52	.28	11	3.1	LT	1340.3	757.7	1351.7		2.256	**92.16**	**92.3**
1 B	2.25	.99	995	123+71	.65	11	7.2	LT	1430.2	808.0	1440.2		2.262	**92.40**	
2 A	2.13	.06	1,030	121+59	.17	11	1.9	LT	1308.2	739.8	1314.7		2.276	**92.97**	**92.4**
2 B	2.50	.65	1,825	73+42	.18	11	2.0	LT	1530.2	860.2	1541.3		2.247	**91.79**	
3 A	2.13	.01	2,005	62+51	.82	11	9.0	LT	1312.5	739.0	1321.8		2.252	**91.99**	**92.0**
3 B	2.25	.32	2,660	22+82	.69	11	7.6	LT	1386.8	780.6	1397.0		2.250	**91.91**	
4 A	2.38	.00	3,000	2+22	.26	11	2.9	LT	1504.5	851.9	1510.3		2.285	**93.34**	**93.5**
4 B	1.75	.84	3,920	143+72	.90	11	9.9	RT	1197.8	679.8	1202.2		2.293	**93.67**	
5 A	2.38	.36	4,180	127+23	.10	11	1.1	RT	1441.7	802.7	1449.0		2.231	**91.14**	**92.6**
5 B	2.25	.07	4,535	104+71	.59	11	6.5	RT	1463.7	832.4	1467.9		2.303	**94.08**	

Percent Density: **92.6**

In Place Pavement Density

- Random locations determined by DOT, (SD 311)
- Nuclear density gauge used
- Gauge calibrated to roadway cutouts (SD 307)
- Form DOT-42

Use of Contractor Tests

- Statistic analysis using QC, QA, IA test results
- Similar/dissimilar (SD 317)
- F-test and t-test statistical evaluation
- Pay Factor
  - 50% → Air Voids (V_a)
  - 50% → In Place Density (% G_{mm})
  - 5% bonus opportunity

F and t tests (Example)

avg	2.446	2.347	4.04	avg	2.445	2.348	4.00	avg	2.447	2.348	4.10
stdev	0.0059	0.0044	0.277	stdev	0.0049	0.0052	0.367	stdev	0.0117	0.00208	0.436
F-test	0.7973	0.5263	0.34	F-test	0.1398	0.288	0.689	F-test	0.06936	0.40246	0.21
	between QC AND QA				between QA AND IA				between IA AND QC		
0.01	OK	OK	OK		OK	OK	OK		OK	OK	OK
0.05	OK	OK	OK		OK	OK	OK		OK	OK	OK
t-test	0.7696	0.8713	0.76	t-test	0.69848	0.9841	0.739	t-test	0.71214	0.87043	0.76
0.01	OK	OK	OK		OK	OK	OK		OK	OK	OK
t-test	0.7696	0.8713	0.76	t-test	0.69848	0.9841	0.739	t-test	0.71214	0.87043	0.76
0.05	OK	OK	OK		OK	OK	OK		OK	OK	OK

Construction

- New tests and mix design procedures are in the Materials Manual, new Specification Book 2015, also at dot.sd.gov
- Gyratory Control Projects (Q_R with RAP)
- M S & T, automated part of Construction Management System (CMS) test forms
- Ride Specification on most Projects
- Asphalt Pavement Analyzer (APA) used on most Projects with specification based on traffic level

Updates

- Intelligent Compaction
- Changes to RAP usage in specification from Research Project
- Warm Mix Asphalt specification from Research Project
- Low temperature cracking tests, Disk-Shaped Compact Tension Test (DCT) and Semi-Circular Bend Test (SCB) done in mix design lab
- Tack changes (increased rate by supplemental spec.)
- Rumble stripes or strips, edge line and centerline for safety

Recertification Exam

- Once the exam has started, you will have approximately 2 hours to complete the exam.
- The Exam is open book/notes (Standard Specifications for Roads and Bridges – 2015, QC/QA Asphalt Concrete Training Manual and the Materials Manual)
- A score of 70% or better is required to pass the exam.